

Build a Better Pencil

MATERIALS

Materials will vary, but should include:

- Post-It® Notes
- unsharpened pencils
- scotch tape
- masking tape
- clay
- scissors
- glue
- rubberbands
- styrofoam
- empty spools
- erasers



PURPOSE

To plan, make, evaluate and modify simple designs and to develop an awareness of constraints such as safety, time, cost, space and availability of materials.

CONTEXT

K-2 students should be given many opportunities to design and make things using a variety of materials and simple tools. This investigation uses a pencil to introduce the idea of planning and evaluating designs. The familiarity of this object will allow students to propose a variety of ideas on how to improve it. The small scale of this design challenge allows for a greater range of solutions that can be carried out using everyday classroom tools and materials.

The purpose of the lesson is to develop students' awareness of constraints. In the early grades, children may be inclined to go with their first idea with little testing. Therefore, students should be encouraged to reflect on the practicality of their designs. However, care must be given in evaluating designs, since students must plan and build many designs in order to develop confidence. Avoid characterizing designs as "good" and "bad" or "possible" and "impossible." Instead, use terminology such as "can do now" and "can't do now."

Students should repeatedly be reminded that the purpose of the activity is to design something that they *can actually make* within the space and time allotted, using available materials. Students who propose large scale designs should be recognized for their ideas and should still have the opportunity to share these designs with classmates, who can comment on what they like about them.

PLANNING AHEAD

Suggested Teacher Background: Read [The Invention of the Post-It® Note](#) from Invention Dimension.

MOTIVATION

To determine students' prior knowledge, begin the lesson by asking:

- How do people come up with new ideas for things to make or build?
- Have you ever come up with a new idea or design?
- Were you able to make or build it? Why or why not?

Present each student with a Post-It® Note.

Ask students:

- What are Post-Its® used for?
- How do you think the inventor came up with the idea for a Post-It®?
- What problem might he have been trying to solve?

After students have offered their ideas, share the story of how the product was created (from the Invention Dimension). Discuss with students the fact that the idea for the

design came from someone trying to solve an everyday problem (a bookmark that kept falling out of a book). To further illustrate this idea, you could also share the story behind [Liquid Paper®](#), also from the Invention Dimension site.

Challenge students to find something else in the classroom that was created by people to solve a problem, or to make a task easier. Students can write their name on the Post-It® distributed previously and tack it to the object that they have found. When students have returned to their seats, allow each to talk about the object they selected, explaining the problem that it solves and/or the task that it makes easier.

DEVELOPMENT

Optional Teacher Background: You may wish to visit [Invention at Play](#), which allows you and your students to explore the playful side of invention. This resource may provide some ideas on how to encourage students who are having difficulty coming up with their own design.

Begin the activity by introducing an example of a "pencil problem" that you would like to solve. For example, you repeatedly lose your pencil when it rolls off your desk. List or draw the problem on chart paper. Ask students to think of a pencil problem that they have encountered.

Ask students:

- Is there anything frustrating about a pencil?
- Have you ever had a problem working with a pencil?

If needed, allow students time to work with a pencil to help them come up with ideas. (Some possibilities include: pencil rolls off desk, eraser always wears out first, pencil always gets lost, pencil won't stay sharpened, pencil hurts the inside of your finger, lead gets on your fingers, you accidentally poke yourself with the sharp end, pencil breaks, doesn't taste good when you chew on it, pencil's not heavy/thick/strong/long enough, etc.)

Accept and record all student ideas on chart paper.

Divide students into pairs or groups of three according to the "pencil problem" they'd like to solve.

Tell students: Your job is to come up with a plan for solving your pencil problem. You may develop as many solutions as you'd like, but you will have to choose just one design to build and present to the class. This design must be able to be built or carried out in the classroom in one class period (choose a time period that your students can conceptualize, such as one class period or one afternoon), using materials that are readily available.

Have groups brainstorm several solutions to the problem. Then have them record the idea that "can be done now" on large chart paper using words and/or pictures.

Have groups present their design to the class. With each group, discuss the following:

1. Materials:
 1. What materials will you need in order to make your design(s)? What tools will you need?
 2. Are the materials and tools available? If not, can we get them? How?
 2. School Policy/Safety:
 0. Would you be following school and safety rules if you built this design?
 1. Could you get hurt working with the tools and materials you have chosen? How?
 2. What would we need to do to keep you and the rest of the class safe? Do we have enough people and materials to use this safety plan?
 3. Cost:
 0. Would we have to buy something in order to build this design? Can we?
 4. Time:
 0. How long will it take you to build your design? Do you have enough time?
 5. Space:
 0. Will you have enough space to build your design? If not, where would you need to go to build it ?
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Have students return to their groups. Ask students to determine: Would you be able to make or build your design *right here, right now*? Why or why not? Allow groups time to decide whether their plan is something they "can do now" or "can't do now" and explain their choice. Those groups who decide that their design is doable should create a list of the materials and tools that they will need to complete their design.

You should look over the lists, alerting students to any tools or materials that are unavailable or potentially dangerous. Those groups that decide their plan is not doable should be allowed time to revise the idea based on teacher and student feedback.

Teacher note: Do not allow students to get stuck in the stage of revising their idea. The point is not to get every group to create a pencil that "works", but rather to get students thinking about constraints and how they affect designs. Discuss the fact that engineers must think about and deal with these same issues, or constraints, when they plan and build their designs. They may not be able to build every design that they create. Sometimes they need to change their designs due to a lack of time or space, or due to safety concerns. They must work to find the design that will work best given the time, materials, tools, money and space available to them.

It is also important to note that many students will understand this notion better through the experience of a "failed" design, when they can readily identify constraints that they hadn't anticipated or considered.

After identifying "can do now" designs, allow students time to try to create their improved pencils. Each group should work with an unsharpened pencil, and should have access to a wide variety of appropriate materials and tools. They should be encouraged to select only those materials that best suit their designs. Some teacher/parent/older student assistance and supervision may be necessary for safety reasons. These individuals should also encourage ongoing discussion as students build and test their designs.

ASSESSMENT

When designs are complete, have groups present their new pencil to the class, sharing both the original sketch and the final design.

Ask students to share the following information:

- Were you able to build your pencil exactly as planned? Why or why not?
 - Did the process of building the pencil change your mind about what you "can do now"?
 - If you had it to do over again, what would you change? Why?
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EXTENSIONS

There are a multitude of classroom problems that students encounter each day - for instance, problems created by being too short - can't erase the top of the blackboard, wobbly chairs, jackets falling out of cubbies, sandwiches getting squished in lunchbags, shoes coming untied, etc.

Have students brainstorm an everyday problem that they would like to solve. Students should record this problem in pictures and/or words, as well as a possible solution to the problem. Students may still need some help in identifying those problems that are both interesting to them and within their capabilities. (*Benchmarks for Science Literacy*, pg. 49)

Choosing small-scale designs will allow students to actually build what they have planned. However, students who propose large-scale designs should be encouraged and recognized for their creativity. Those designs that are impossible to build in the classroom can offer valuable opportunities for addressing the idea of constraints.

After students have determined what problem they would like to solve and a possible design solution, they should determine whether it is something they "can do now" or "can't do now". Students should defend their answers. (This may need to be done verbally.)